LONDON-WEST MIDLANDS ENVIRONMENTAL STATEMENT

Volume 5 | Technical Appendices

CFA2 | Camden Town and HS1 Link

Flood risk assessment (WR-003-002)

Water resources

November 2013

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Department for Transport

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High Speed Two (HS2) Limited,
Eland House,
Bressenden Place,
London SW1E 5DU

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1 Introduction

1.1 Structure of the water resources and flood risk assessment appendices

1.1.1 The water resources and flood risk assessment appendices comprise three parts. The first of these is a route-wide appendix (Volume 5: Appendix WR-001-000).

1.1.2 Specific appendices for each community forum area (CFA) are also provided. For the Camden Town and HS1 Link area (CFA2) these are:

- a water resources assessment (Volume 5: Appendix WR-002-002); and
- a flood risk assessment (i.e. this appendix).

1.1.3 Maps referred to throughout the water resources and flood risk assessment appendices are contained in the Volume 5, Water Resources and Flood Risk Assessment Map Book.

1.2 Scope and structure of this assessment

1.2.1 This flood risk assessment (FRA) considers the assessment of flood risk in CFA2. The assessment has been carried out in accordance with the requirements of the National Planning Policy Framework (NPPF)[1] which aims to prevent inappropriate development in areas at risk of flooding and to ensure that, where development is necessary in areas at risk of flooding, it is safe without increasing flood risk elsewhere.

1.2.2 The FRA methodology and a review of the relevant local planning policy documents are provided in Section 2 of this report. The design criteria are provided in Section 3 and Section 4 documents the sources of information that have been reviewed. Section 5 provides a description of the planned works within CFA2. Section 6 considers baseline flood risk and the risk of flooding to the Proposed Scheme from all relevant sources. Flood risk mitigation measures included within the Proposed Scheme are detailed in Section 7. The effect of the Proposed Scheme on the risk of flooding is considered in Section 8.

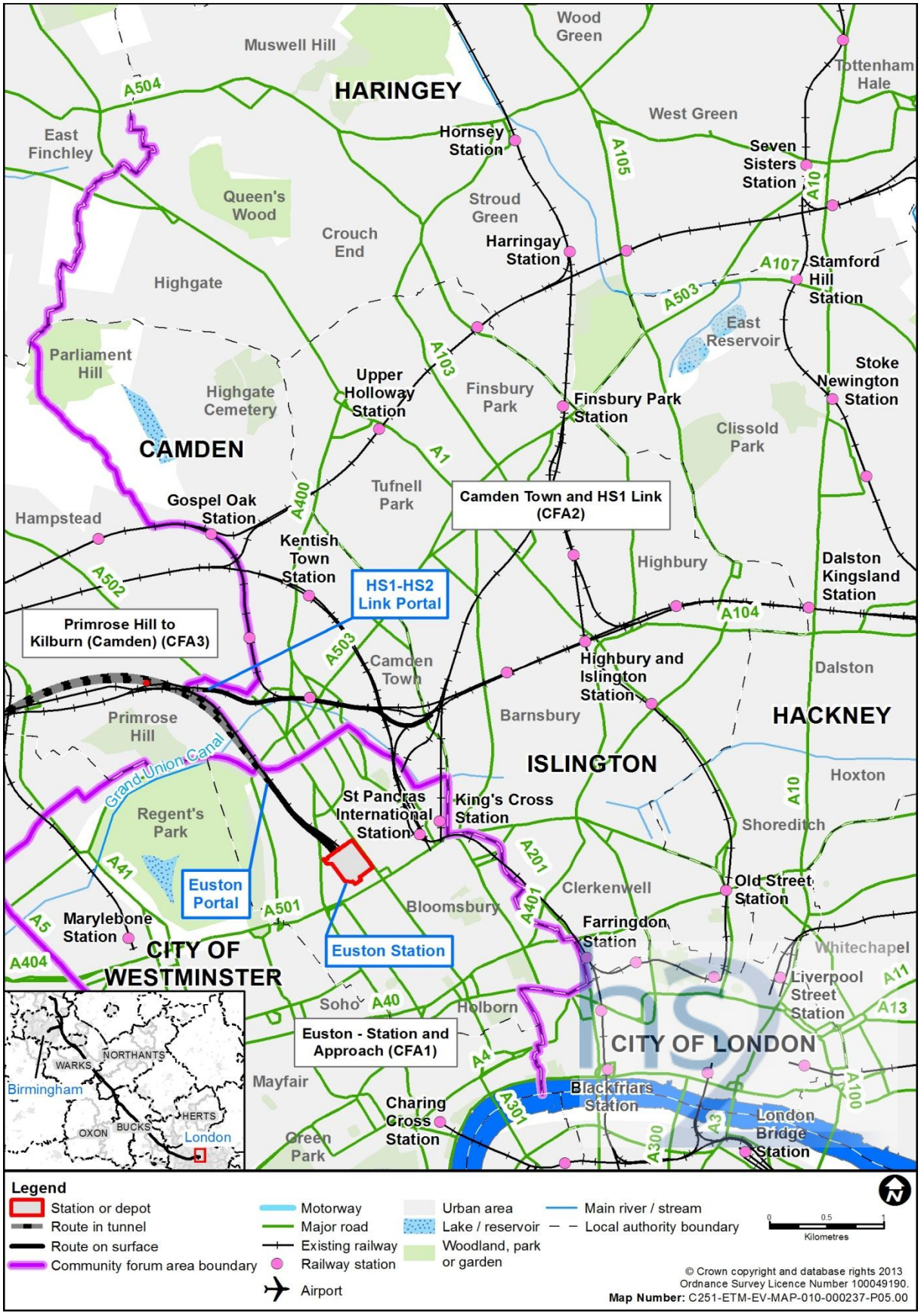
1.3 Location

1.3.1 CFA2 extends from the A5200 York Way in the east, to Regent's Park Road Bridge in the west (see Maps CT-05-03, CT-05-04 and CT-05-143 in Volume 2, CFA2 Map Book). CFA2 is entirely within the London Borough of Camden (LBC). The adjacent study areas are the Euston - Station and Approach area (CFA1) to the south and the Primrose Hill to Kilburn (Camden) area (CFA3) to the west, as shown in Figure 1.

1.3.2 The HS1-HS2 Link is a short section of track which will link the Proposed Scheme to the existing HS1 alignment. It is approximately 2.3km in length and will run on connected viaducts. The study area extends a distance of 500m from the centre line of the route.

[1] Department for Communities and Local Government (2012), *National Planning Policy Framework*.

Figure 1: Camden Town and HS1 Link area



2 Flood risk assessment methodology

2.1 Source-pathway-receptor model

2.1.1 Flood risk is assessed using the source-pathway-receptor model. In this model individual sources of flooding within the study area are identified. The primary source of flooding is rainfall which is a direct source in the short-term (surface water flooding) and can lead to flooding from watercourses (river flooding) and overloaded man-made collection systems (sewer flooding) in the short- or medium-term. Stored rainfall, either naturally in below ground aquifers and natural lakes or artificially in impounded reservoirs and canals can lead to flooding when the storage capacity of the system is exceeded. A final source of flooding arises from tidal effects and storm surges caused by low pressure systems over the sea.

2.1.2 For there to be a risk of flooding at an individual receptor there must be a pathway linking it to the source of flooding. The pathways within the study area are assessed by reviewing national datasets that show the spatial distribution of flood risk. The associated risk magnitude is then categorised.

2.1.3 Receptors considered in this assessment include the Proposed Scheme and existing development within 500m of the Proposed Scheme. The Proposed Scheme includes all associated permanent infrastructure. Areas of interest are identified through comparison of the national spatial datasets with the design drawings. Where a risk is identified mitigation is proposed in line with recommendations in the NPPF.

2.1.4 Existing receptors within the study area are identified using Ordnance Survey (OS) mapping information. A high-level screening assessment is then undertaken to identify receptors that are within or in close proximity to an area of flood risk via pathways indicated using the flood risk data sources listed below. The vulnerability of each receptor is classified using Table 2 of the NPPF Technical Guidance Document[2].

2.1.5 The assessment then considers the vulnerability of the receptor with reference to the flood risk category of the source using Table 3 of the NPPF Technical Guidance Document and assesses whether the Proposed Scheme has any potential to influence or alter the risk of flooding to each receptor. Where such potential has been identified, mitigation is proposed based on further analysis.

2.2 Flood risk categories

2.2.1 The level of flood risk is categorised by assessing the design elements against the datasets for each source. A matrix showing the flood risk category associated with each flooding source is presented in Table 1.

[2] Department for Communities and Local Government (2012), *National Planning Policy Framework Technical Guidance.*

Table 1: Flood risk category matrix for all flooding sources

Source of flooding	Flood risk category				
	No risk	**Low**	**Medium**	**High**	**Very high**
Rivers		Flood Zone 1	Flood Zone 2	Flood Zone 3a	Flood Zone 3b
Surface water	No surface water flooding.	Surface water flooding <0.3m for 1 in 200 years event.	Surface water flooding >0.3m for 1 in 200 years event; and Surface water flooding <0.3m for 1 in 30 years event.	Surface water flooding >0.3m for 1 in 30 years event.	
Groundwater		Very low-low	Moderate	High-very high	
Drainage and sewer systems	No sewer in vicinity of site.	Surcharge point >20m from site and no pathways.	Surcharge point within 20m of site and restricted pathways.	Sewer network crosses site and pathways exist.	
Artificial sources	Outside of inundation mapping/no pathway exists.	Within inundation mapping/ pathway exists.			

2.3 Regional and local flooding planning policy documents

2.3.1 The lead local flood authority (LLFA) for CFA2 is LBC which is also the local planning authority for this study area. The recommendations from the LBC Preliminary Flood Risk Assessment (PFRA)[3] have been reviewed in undertaking this assessment. The LBC Local Flood Risk Management Strategy (LFRMS)[4] was approved in June 2013.

2.3.2 Acting as the local planning authority, LBC has also produced a strategic flood risk assessment (SFRA)[5] in conjunction with a number of surrounding local authorities.

London Borough of Camden Preliminary Flood Risk Assessment

2.3.3 The LBC PFRA indicates that there have been no identifiable past floods in the borough that have had significant harmful consequences. In the borough, however, future flood risk is estimated to be high based on the Drain London surface modelling outputs.

2.3.4 The LBC PFRA confirms that the extent of the Greater London indicative flood risk area is correct within the borough. The entire extent of the borough lies within the indicative flood risk area. Further stages of the Flood Risk Regulations 2009[6] process

[3] Halcrow (2011), *Camden Preliminary Flood Risk Assessment*
[4] London Borough of Camden (2013), *Managing flood risk in Camden: The Camden flood risk management strategy*
[5] Mouchel (2008), *North London SFRA*; North London Waste Authority
[6] *Flood Risk Regulations 2009* (SI 2009 No. 3042), London, Her Majesty's Stationery Office.

(i.e. flood risk mapping and flood risk management plans) will therefore be undertaken in due course. The LBC PFRA states that the current locally agreed spatial surface water flood risk information dataset is from the modelling activities undertaken as part of the Drain London project.

London Borough of Camden Local Flood Risk Management Strategy

2.3.5 The LBC LFRMS guides the planning process in relation to flood risk across all categories and outlines key policies in relation to development within LBC. The strategy aims:

- to understand and explain the level of risk affecting the residents and businesses of Camden;
- to provide an action plan for areas at particular risk from surface water flooding;
- to highlight the actions that all partners, businesses and residents in Camden should be taking to manage flood risk; and
- to take a sustainable and holistic approach to flood management, seeking to deliver wider environmental and social benefits.

Thames Region Catchment Flood Management Plan

2.3.6 The Thames Region Catchment Flood Management Plan (CFMP)[7] sets out policies for the sustainable management of flood risk across the Thames catchment over the coming 50-100 years taking climate change into account. CFA2 lies within the TE2100 Policy Unit and the preferred policy is Policy 4, which includes areas of low, moderate or high risk where the Environment Agency is already managing the flood risk effectively but where further action may need to be taken to keep pace with climate change.

2.3.7 The Thames Region CFMP states that the most sustainable approach to managing future flood risk will be to bring about adaptation of the urban environment. It indicates that strategic scale planning is a key to achieving the needs of the community and managing flood risk in a more sustainable way and that emergency planning is integral to the approach to managing extreme flood events.

London Regional Flood Risk Appraisal

2.3.8 The London Regional Flood Risk Appraisal (RFRA)[8] provides a broad regional understanding of the risk of flooding in Greater London to feed into each of the LLFA SFRA and PFRA reports. Recommendation 7 states that regeneration and redevelopment of London's river corridors offers a crucial opportunity to reduce flood risk in these areas.

North London Strategic Flood Risk Assessment

2.3.9 The North London SFRA was completed in 2008 as part of the evidence base for the North London Waste Plan. LBC is one of seven participating boroughs that are

[7] Environment Agency (2008), *Thames Catchment Flood Management Plan.*
[8] Greater London Authority (2009), *London Regional Flood Risk Appraisal.*

included in the report. The North London SFRA states that LBC has a particularly high risk of flooding from sewer and surface water sources, while river flood risk remains low due to the lack of watercourses.

London Borough of Camden Core Strategy

2.3.10 Policy CS13 of the LBC adopted Core Strategy[9] seeks to make Camden a water efficient borough. It also seeks to minimise the potential for surface water flooding by requiring promoters of development to avoid harm to the water environment, water quality or drainage systems. The policy also seeks to prevent or mitigate local surface water and down-stream flooding especially in areas up-hill from and in areas known to be at risk from surface water flooding.

London Borough of Camden Adopted Development Policies

2.3.11 Policy DP23 of the LBC adopted Development Policies[10] requires that developments reduce their water consumption and the risk of flooding by:

- incorporating water efficient features and equipment;
- limiting the amount and rate of runoff and waste water to reduce the risk of flooding;
- reducing the pressure placed on the storm water and sewer network; and
- ensuring that development is assessed for upstream and downstream groundwater flood risks in areas where historic underground streams are known to have been present.

2.3.12 Policy DP23 requires all new developments in areas identified as having a risk of surface water flooding in LBC to achieve a greenfield rate of runoff. All other development that increases the amount of impervious surface is expected to minimise the amount and rate of runoff from the site to at least the existing rate. The Proposed Scheme will pass through areas that are identified as having historically flooded within LBC during the 1975 and 2002 events; it will not, however, pass through areas with the potential to be at risk of surface water flooding as shown in Map 2 within the LBC adopted Development Policies document.

2.3.13 Policy DP22 requires development to be resilient to climate change by ensuring schemes include appropriate adaptation measures such as limiting runoff and reducing water consumption.

[9] London Borough of Camden (2010), *Adopted Core Strategy*
[10] London Borough of Camden (2010), *Adopted Development Policies*

3 Design criteria

3.1.1 It is a requirement of the design that the Proposed Scheme shall be protected against flooding from any source during the 1 in 1,000 years return period (0.1% annual probability) rainfall event, with water levels not rising closer than 1m to the top of rail level.

3.1.2 In accordance with the NPPF, an allowance for climate change is included in the assessment by assuming that peak rainfall intensity will increase by 30% and that peak river flows will increase by 20%.

4 Data sources

4.1 Primary Datasets

4.1.1 Consistent with the requirements of the NPPF this assessment considers the risk of flooding from rivers, direct surface water runoff, rising groundwater, overwhelmed drainage and sewer systems, and artificial sources such as reservoirs, lakes and canals.

4.1.2 The Proposed Scheme lies entirely outside the extent of flooding from the sea and therefore the risk of flooding from tidal sources is not considered in this assessment.

4.1.3 The primary datasets for each source of flooding used to assess the design elements are presented in Table 2. A high-level review of the risk of flooding and potential impacts is undertaken on the basis of these datasets across all flood sources. Where this review indicates potentially significant impacts on the risk of flooding, or a risk of flooding to the line, further investigation in the form of hydraulic modelling is undertaken.

Table 2: Flood risk assessment data sources

Source of flooding	Datasets reviewed	Data owner
Rivers	Flood zone mapping. Detailed River Network (DRN). Catchment hydraulic models.	Environment Agency
Surface water	Flood Map for Surface Water (FMfSW). Local surface water flood mapping.	Environment Agency LLFA
Groundwater	Areas susceptible to groundwater flooding. 1:50,000 geological mapping (superficial and bedrock). Potential for elevated groundwater.	British Geological Survey (BGS) LLFA
Drainage and sewer systems	Sewer network plans. Lost river location plans.	Thames Water Utilities Limited (TWUL) Local planning authority
Artificial sources	Reservoir inundation mapping (RIM) Canal infrastructure locations. Trunk water main asset plans.	Environment Agency Canal & River Trust TWUL

4.2 Site familiarisation visits

4.2.1 No site familiarisation visits were undertaken within this study area.

5 The proposed development

5.1 Topography and land use

5.1.1 The topography is generally flat and any natural variations in topography tend to be masked by the overlying urban development.

5.1.2 The area is heavily urbanised with no surface watercourses present other than the Grand Union Canal (the Regent's Canal). There is industrial and modern residential development adjacent to the rail, canal and road infrastructure.

5.1.3 The North London Line (NLL), which is part of the London Overground railway network, is on viaduct on an east-west axis through the area and numerous bridges cross the local roads. The route of the Proposed Scheme will cross the Midland Main Line (MML) to the south of Agar Grove and east of Camley Street. The principal highways through the area include the A5200 York Way, A5202 St Pancras Way, A503 Camden Road, A400 Kentish Town Road and A502 Chalk Farm Road.

5.2 Local flood risk receptors

5.2.1 The vulnerability of each local receptor with an identified pathway within the study area is presented in Table 3. The vulnerability is classified in accordance with the recommendations of Table 2 in the NPPF Technical Guidance Document and the Scope and Methodology Report (SMR) (see Volume 5: Appendix CT-001-000/1) and the SMR Addendum (see Volume 5: Appendix CT-001-000/2).

Table 3: Vulnerability of local receptors in CFA2

Local receptor	Description	Vulnerability classification	Source/pathway
Properties in Barnsbury	Residential dwellings	More vulnerable	Surface water 200 years - deep
East Coast Main Line	Railway corridor	Highly vulnerable	Surface water 30 years - deep
Properties in the Broadfield Lane Estate	Residential dwellings	More vulnerable	Surface water 200 years - deep
Midland Main Line	Railway corridor	Highly vulnerable	Surface water 30 years - deep Hampstead and Highgate ponds failure
Camley Street	Commercial properties	Less vulnerable	Surface water 200 years - deep Hampstead and Highgate ponds failure
Commercial developments on St Pancras Way	Commercial properties	Less vulnerable	Surface water 200 years - deep
Properties on Lyme Street	Residential dwellings	More vulnerable	Surface water 200 years - deep

Local receptor	Description	Vulnerability classification	Source/pathway
Properties on Hawley Street and Kentish Town Road	Residential dwellings	More vulnerable	Surface water 200 years - deep
Properties in Camden Town	Residential dwellings and associated infrastructure	More vulnerable	Surface water 200 years - deep
St Michael's Church and welfare centre	Place of worship and community centre	Less vulnerable	Surface water 200 years - deep
Shops and bars on Chalk Farm Road close to Morrisons supermarket	Commercial properties	Less vulnerable	Surface water 200 years - deep

5.3 Description of the Proposed Scheme

5.3.1 The route of the Proposed Scheme through this area will be approximately 2.3km in length and will run on existing connected viaducts (the HS1 Viaduct, the NLL Viaduct, the Kentish Town Viaduct and the Chalk Farm Viaduct) that, with the exception of the HS1 Viaduct, serve the London Overground and freight services. The tracks which currently carry the NLL will be realigned on a disused track formation on the north side of the viaducts to allow the Proposed Scheme's services to pass along the southern side of the viaducts. Along the route in this section, there will be a number of partial/full bridge replacements and refurbishments to viaducts.

5.3.2 North of Juniper Crescent, the route will enter a new ramp constructed between the Morrisons supermarket access road and a tunnel portal (tunnel entrance) approximately 30m east of Regent's Park Road Bridge. The route will then proceed in a single bore tunnel into CFA3, where it will continue onto Old Oak Common running between the twin bore Euston Tunnel. The HS1-HS2 Link will connect to the new high speed lines at Old Oak Common Station.

6 Existing flood risk

6.1 Historical flooding incidents

6.1.1 The LBC PFRA does not identify any past floods within this study area that have had significant harmful consequences that would be reportable to the European Union (EU).

6.1.2 The North London SFRA reports that a large area in the north of Camden was affected by surface water flooding in August 2002 which was the result of heavy rainfall inundating the public sewer system. A similar region of Camden was affected by surface water/sewer flooding in 1975. Flooding of Kentish Town Road and Hawley Road is shown to have occurred during the 1975 flood event within the study area. [11]

6.1.3 The LBC PFRA states that sewer flooding occurred within the borough in August 2004, September 2005 and July 2007. Specific locations of these flood incidents are not provided in the document.

6.1.4 The North London SFRA reports that no groundwater flooding incidents have been recorded by the Environment Agency in LBC.

6.2 Risk of flooding from rivers

6.2.1 The Proposed Scheme will not cross any Environment Agency main rivers or ordinary watercourses within this study area and the entire study area is within Flood Zone 1.

6.3 Risk of flooding from surface water sources

6.3.1 The Drain London modelling outputs and the Environment Agency FMfSW have been reviewed to form the basis of the assessment of the risk of surface water flooding. In general the PFRA reports indicate a good correlation between the FMfSW and the Drain London modelling. The Drain London modelling, however, considers the underground drainage infrastructure in a higher level of detail and is therefore the superior dataset.

6.3.2 There are areas within the study area that have a high risk of surface water flooding.

Camley Street

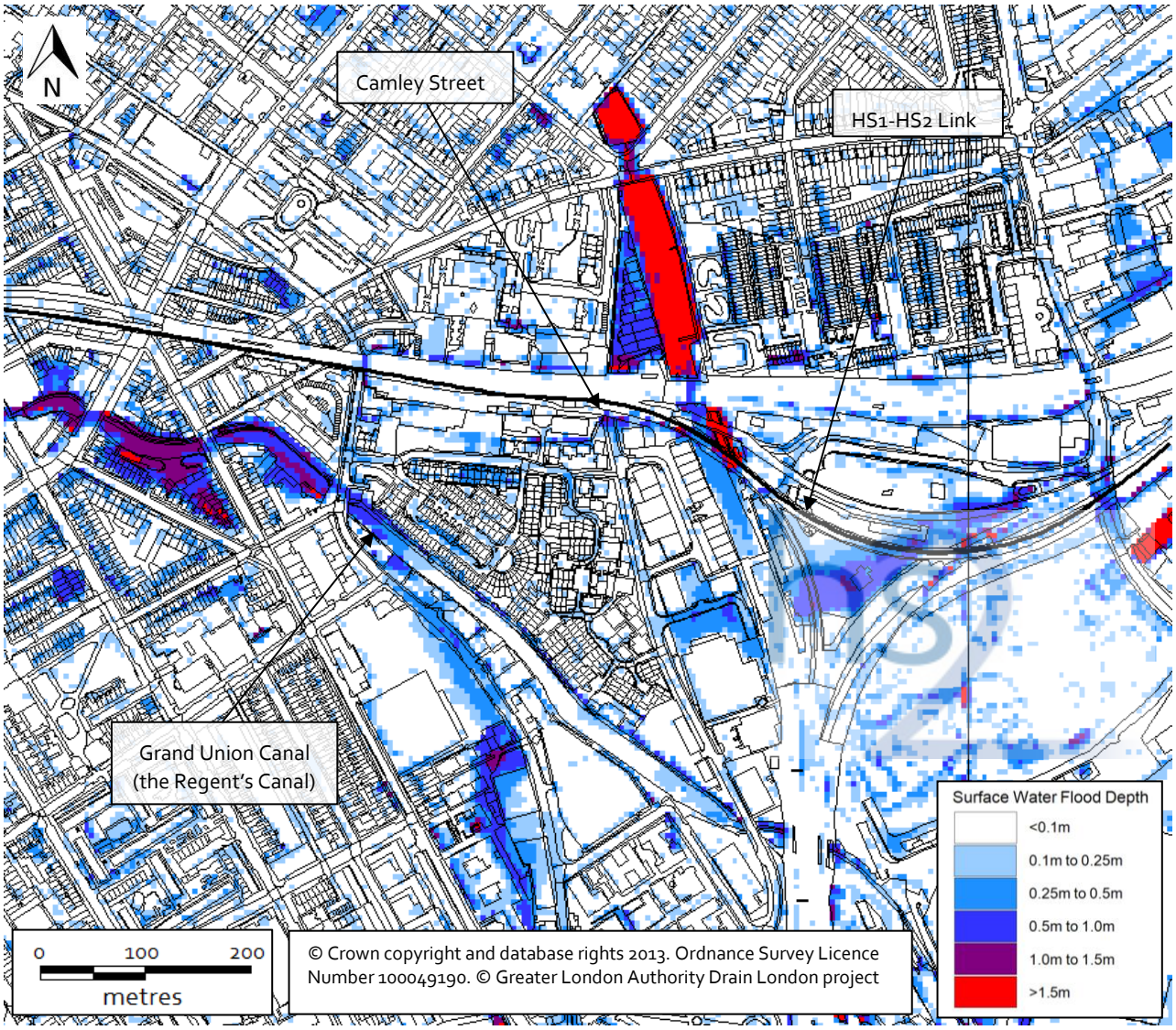
6.3.3 Surface water flooding datasets from the LBC PFRA show the tracks of the MML to be at risk of flooding during the 1 in 200 years return period (0.5% annual probability) flood event to depths up to 1.5m, as shown in Figure 2. In this location the MML is in a dive under beneath residential properties in Camden Town. The cutting for the dive under may be as much as 5m below surrounding ground levels. It is unclear whether the continuation of the dive under was used in the surface water flood modelling in this location or whether the model was based solely on digital terrain model (DTM) data which would not include the tunnel. In addition any Network Rail (NR) provision

[11] London Borough of Camden (2003), *Floods in Camden: Report of the Floods Scrutiny Panel.*

for higher capacity drainage within this dive under would not have been included in the modelling.

6.3.4 The adjacent Camley Street and the properties in-between are also shown to be at risk of surface water flooding. The secondary dataset, the FMfSW (Map WR-01-002 (Volume 5, Water Resources and Flood Risk Assessment Map Book)), does not show any deep flooding at the Camley Street site.

Figure 2: 1 in 200 years return period (0.5% annual probability) surface water flood depth in the vicinity of Camley Street from Drain London dataset



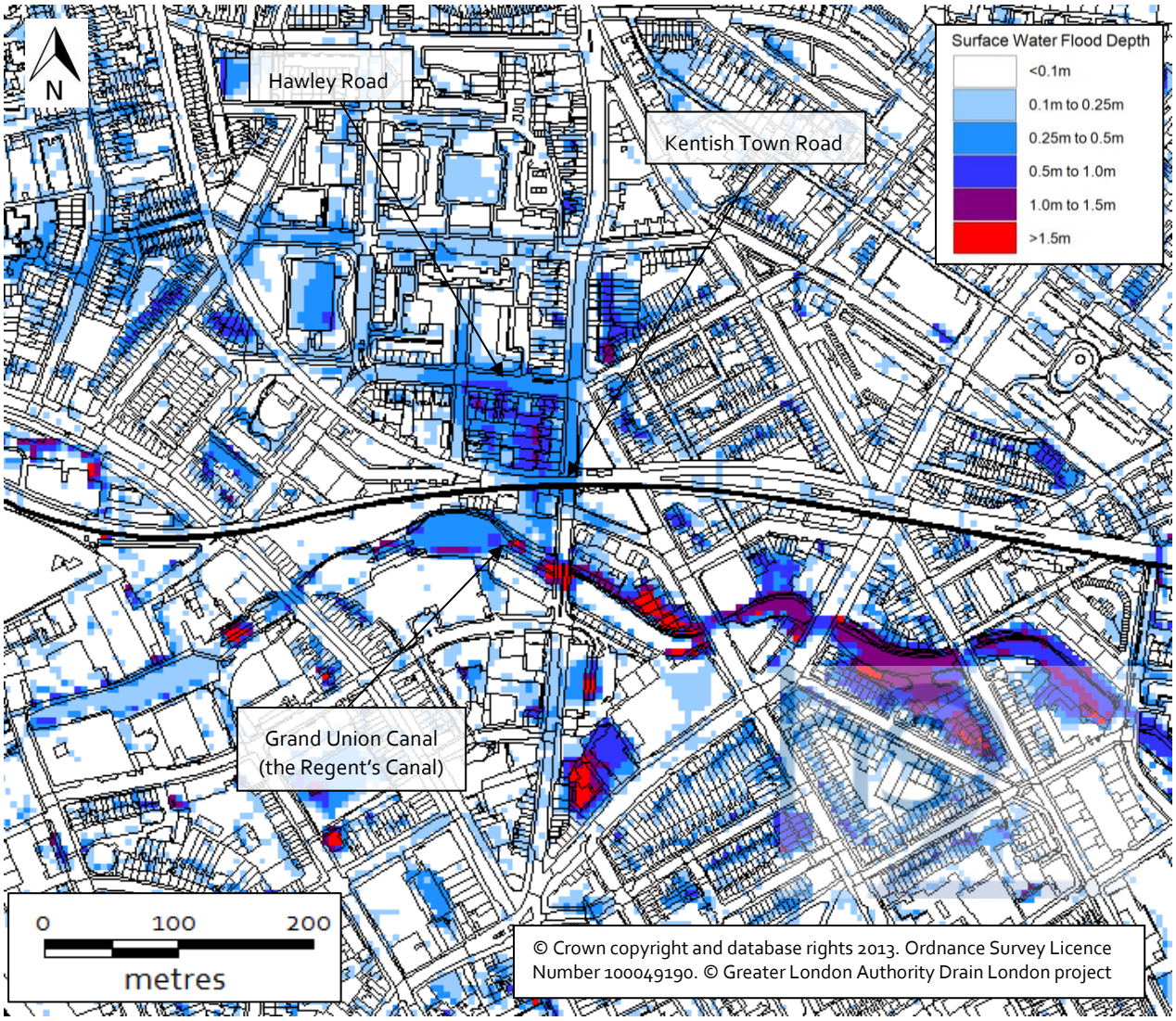
6.3.5 The Proposed Scheme will be on the existing viaduct throughout this area with top of rail levels at approximately 34m above Ordnance Datum (AOD). This is approximately 6m higher than surrounding ground levels.

6.3.6 There will be no significant risk of surface water flooding to the Proposed Scheme at Camley Street.

Kentish Town Road and Hawley Road

6.3.7 Further to the west there is an area shown to be at risk of flooding during the 1 in 200 years return period (0.5% annual probability) flood event with localised depths up to 1.5m, as shown in Figure 3. This is associated with a localised topographic depression to the south of Hawley Road and to the west of Kentish Town Road. These streets are shown to have experienced flooding during the 1975 surface water flooding event.

Figure 3: 1 in 200 years return period (0.5% annual probability) surface water flood depth at Kentish Town Road and Hawley Road from Drain London dataset



6.3.8 At this location the route will be on existing viaduct with top of rail level at approximately 34m AOD approximately 8m above surrounding ground levels.

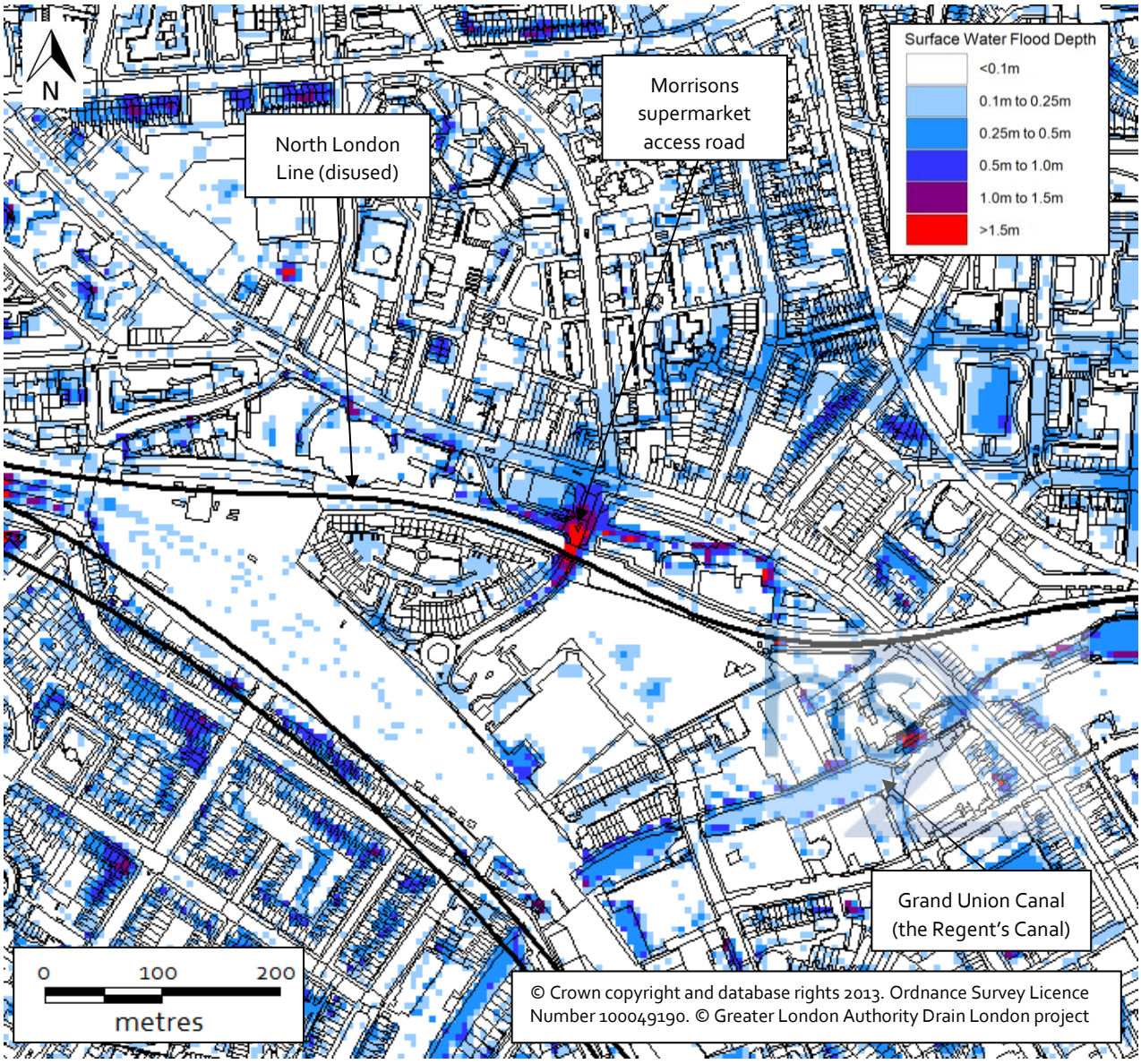
6.3.9 There will be no significant risk of surface water flooding to the Proposed Scheme at the crossing of Kentish Town Road.

Morrisons supermarket access road

6.3.10 The approach way to the HS1-HS2 Link portal is an area at risk of flooding during the 1 in 200 years return period (0.5% annual probability) flood event to depths up to 1.5m

as shown in Figure 4. In this location the Morrisons supermarket access road is in a deep underpass beneath the existing NLL. The level at the invert of the underpass is approximately 26.5m AOD. Ground levels to the north of the NLL are approximately 27-28m AOD whereas ground levels to the south of the NLL are approximately 33-34m AOD.

Figure 4: 1 in 200 years return period (0.5% annual probability) surface water flood depth at the Morrisons supermarket access roadfrom Drain London dataset



6.3.11 The route will follow the alignment of the existing NLL with top of rail levels at approximately 34m AOD. There is no significant surface water flooding predicted away from the road underpass.

6.3.12 There will be no significant risk of surface water flooding to the Proposed Scheme at the crossing of the road leading to Juniper Crescent and Morrisons.

6.4 Risk of flooding from groundwater

6.4.1 The LBC PFRA does not identify any areas at risk of elevated groundwater within the study area. Consequently, there will be a low risk of groundwater flooding to the Proposed Scheme within this study area.

6.5 Risk of flooding from drainage systems

6.5.1 The Proposed Scheme will pass through heavily urbanised areas within CFA2 and therefore above ground infrastructure will be located close to the existing sewerage network and associated manholes. The PFRA and SFRA studies report a number of historical incidents of sewer flooding; the exact location of these incidents, however, is not available.

6.5.2 The sewer network in this area is predominantly combined (i.e. conveys both foul water and surface water) and therefore the risk of flooding from sewers is comparable to the risk of flooding from surface water sources which is described in Section 6.3 of this report.

6.5.3 The culverted course of the lost River Fleet will be crossed at two locations by the Proposed Scheme. Firstly at the Camden Road Viaduct and again at the St Pancras Way Bridge. This watercourse now forms part of the Fleet Storm Relief Sewer. There are no construction works that will affect the structural integrity of this sewer within the study area.

6.5.4 There will therefore be no significant risk of flooding from drainage and sewer systems to the Proposed Scheme within CFA2 further to the risk from surface water sources described in Section 6.3 of this report.

6.6 Risk of flooding from artificial sources

Canals

6.6.1 The Proposed Scheme will pass within 15m of the Grand Union Canal (the Regent's Canal). The canal is at or below ground level within the study area and therefore does not have an associated risk of embankment breach that could lead to offsite flooding. Consequently, there will be no risk of flooding to the Proposed Scheme from canals.

Reservoirs

6.6.2 The Proposed Scheme will cross an area that is shown in the Environment Agency RIM to have a residual risk of flooding from Hampstead and Highgate Ponds. The extent of flooding follows the alignment of the MML between Kentish Town and St Pancras stations. Camley Street is also shown to be within the extent of flooding. At this location the Proposed Scheme will be on an existing viaduct approximately 7m above surrounding ground levels, with construction works limited to strengthening of the bridges. These water bodies are subject to the requirements of the Reservoirs Act 1975[12] (as amended by the Flood & Water Management Act 2010[13]) and therefore the

[12] *Reservoirs Act 1975* (c.23). London, Her Majesty's Stationery Office.
[13] *Flood and Water Management Act 2010* (c.29). London, Her Majesty's Stationery Office.

likelihood of failure is extremely low. There will be no significant risk of flooding to the Proposed Scheme as a result of a failure of impounded reservoirs.

Water Mains

6.6.3 The Proposed Scheme will cross a number of TWUL trunk water supply mains within CFA2. These include:

- a 914mm diameter cast iron water main in Baynes Road;
- a 914mm diameter cast iron water main and a 432mm diameter cast iron water main in Camden Road; and
- a 406mm diameter cast iron water main in Kentish High Road.

6.6.4 At all of these locations the Proposed Scheme will be on viaduct approximately seven to eight metres above surrounding ground levels. Therefore there will be no significant risk of flooding to the Proposed Scheme from these water mains.

6.7 Summary of baseline flood risk

Table 4: Summary of baseline flood risk for all sources of flooding in CFA2

Source of flooding	Location of flooding source	Flood risk category	Elements at risk	Assessment of risk
Surface water	Camley Street	High Surface water 30 years - deep	HS1-HS2 Link.	The Proposed Scheme will be on existing viaduct >1m above ground levels- no risk.
	Kentish Town Road and Hawley Street	Medium Surface water 200 years - deep	HS1-HS2 Link.	The Proposed Scheme will be on existing viaduct >1m above ground levels- no risk.
	Juniper Crescent and Morrisons access road	High Surface water 30 years - deep	HS1-HS2 Link.	The Proposed Scheme will be on existing viaduct >1m above ground levels- no risk.
Artificial sources (reservoirs)	Hampstead and Highgate Ponds	Low Source and pathway	HS1-HS2 Link.	The Proposed Scheme will be on existing viaduct >1m above ground levels- no risk.
Artificial sources (water mains)	TWUL trunk water mains	Low Source and pathway	HS1-HS2 Link.	The Proposed Scheme will be on existing viaduct >1m above ground levels- no risk.

7 Flood risk management measures

7.1 Risk of flooding from rivers

7.1.1 There will be no risk of flooding from rivers to the Proposed Scheme, nor any anticipated effects on the risks of flooding from rivers within the study area arising from the Proposed Scheme. Therefore, no specific mitigation will be required.

7.2 Risk of flooding from surface water

7.2.1 There will be no risk of flooding from surface water sources to the Proposed Scheme, nor any anticipated effects on the risks of flooding from surface water sources within the study area arising from the Proposed Scheme. Therefore, no specific mitigation will be required.

7.3 Risk of flooding from groundwater

7.3.1 There will be no risk of flooding from groundwater to the Proposed Scheme, nor any anticipated effects on the risks of flooding from groundwater within the study area arising from the Proposed Scheme. Therefore, no specific mitigation will be required.

7.4 Risk of flooding from drainage systems

7.4.1 There will be no significant risk of flooding from drainage systems to the Proposed Scheme, nor any anticipated effects on the risks of flooding from drainage systems within the study area arising from the Proposed Scheme. Therefore, no specific mitigation will be required.

7.5 Risk of flooding from artificial sources

7.5.1 There are no instances where the Proposed Scheme will be at significant risk of flooding from artificial sources within CFA2 and consequently no specific mitigation will be required. There will be no significant effects on the risk of flooding from artificial sources arising from the Proposed Scheme within CFA2. Therefore, no specific mitigation will be required.

8 Post-development flood risk assessment

8.1 Local receptors

8.1.1 In addition to the risk of flooding that exists to the Proposed Scheme, there is potential for the Proposed Scheme to affect the risk of flooding to third party receptors by altering flow mechanics across the range of flood sources. All local receptors with a potential flood risk are identified in Section 5.2 of this report. For the Proposed Scheme to have an impact on a given receptor, the identified pathway for that receptor must be shared by both the subject receptor and the Proposed Scheme with the result that a number of cases can be excluded immediately. Table 5 summarises the shared pathways between the Proposed Scheme and each receptor and identifies cases where no shared pathway exists.

Table 5: Shared flood risk pathways in CFA2

Local receptor	Vulnerability classification as per the NPPF	Pathway	Shared pathway between Proposed Scheme and receptor
Properties in Barnsbury	More vulnerable	Surface water 200 years - deep	No shared pathway.
East Coast Main Line	Highly vulnerable	Surface water 30 years - deep	No shared pathway.
Properties in the Broadfield Lane Estate	More vulnerable	Surface water 200 years - deep	No shared pathway.
Midland Main Line	Highly vulnerable	Surface water 30 years - deep Hampstead and Highgate ponds failure	No shared pathway.
Camley Street	Less vulnerable	Surface water 200 years - deep Hampstead and Highgate ponds failure	HS1-HS2 Link.
Commercial developments on St Pancras Way	Less vulnerable	Surface water 200 years - deep	No shared pathway.
Properties on Lyme Street	More vulnerable	Surface water 200 years - deep	No shared pathway.
Properties on Hawley Street and Kentish Town Road	More vulnerable	Surface water 200 years - deep	HS1-HS2 Link.
Properties in Camden Town	More vulnerable	Surface water 200 years - shallow	No shared pathway.
St Michael's Church and welfare centre	Less vulnerable	Surface water 200 years - deep	No shared pathway.
Shops and bars on Chalk Farm Road close to Morrisons supermarket	Less vulnerable	Surface water 200 years - deep	HS1-HS2 Link.

8.1.2 There is also the potential for the Proposed Scheme to change the baseline risk of flooding described in the Section 6 of this report. Though designed such that the

probability of the Proposed Scheme flooding in any given year is less than 1 in 1,000, any change to the baseline risk of flooding could impact on the assessment of flood risk to the Proposed Scheme. All cases of flood risk discussed in Section 6 of this report are therefore reconsidered regardless of the presence or otherwise of third party local receptors.

8.2 Impact on risk of flooding from rivers

8.2.1 The Proposed Scheme will not cross any Environment Agency main rivers or ordinary watercourses within this study area and the Proposed Scheme will therefore not lead to a change in the risk of flooding from rivers.

8.3 Impact on risk of flooding from surface water

8.3.1 Any above ground infrastructure has the potential to alter overland flow routes, thereby changing the risk of flooding to local receptors through displacement of flood waters and alteration to flow conveyance times.

8.3.2 At all locations within this study area where the route will cross land at risk of surface water flooding it will be on viaduct and therefore raised above surrounding ground levels. There will be no increase in the footprint areas beneath the underbridges where there is a risk of surface water flooding and in some cases existing viaduct piers will be removed.

8.3.3 The Proposed Scheme will therefore not disrupt overland flow pathways or displace floodwaters and the risk of surface water flooding as a result of the Proposed Scheme within this study area will be negligible.

8.4 Impact on risk of flooding from groundwater

8.4.1 There will be no significant below ground construction within this study area. The Proposed Scheme will not impact on groundwater levels and consequently there will be no effect on the risk of flooding from groundwater within the study area.

8.5 Impact on risk of flooding from drainage systems

8.5.1 Connections to the surface water sewer network will be agreed with TWUL in order to avoid creating an additional burden on the existing sewer networks. There will be no significant increase in the area of impermeable surfaces following construction as all areas are currently developed. The Proposed Scheme will therefore not lead to a change in the risk of flooding from drainage and sewer systems within the study area.

8.6 Impact on risk of flooding from artificial sources

Canals

8.6.1 There will be no construction works adjacent to the Grand Union Canal (the Regent's Canal) and there will therefore be no change in the risk of flooding from canals.

Reservoirs

8.6.2 There will be no significant permanent works at Camley Street within the extent of predicted reservoir inundation. There will be no impact on the residual risk of flooding

from the Hampstead and Highgate Ponds and, since this water body is subject to the requirements of the Reservoirs Act 1975 (as amended), the likelihood of any flooding occurring is extremely low. The impact of the Proposed Scheme on the actual risk of flooding from impounded reservoir failure will be negligible.

Water mains

8.6.3 The settlement of the ground along the length of all water mains due to tunnelling and the potential damage to the pipes due to additional strain in the surrounding material will be assessed prior to and during construction. Although an increased risk of failure exists during construction this will be managed as part of the construction programme. Provided the construction risks are appropriately managed the risk of failure of these water mains in the permanent case will not increase as a result of the Proposed Scheme.

8.7 Summary of potential impacts and effects on flood risk

Table 6: Summary of potential flood risk impacts and effects in CFA2

Receptor	Vulnerability classification	Pathway	Impacts and effects
General Proposed Scheme		Rivers	No effects expected.
		Surface water	Rainfall will be collected, attenuated and discharged to existing sewerage infrastructure. No significant effects expected.
		Groundwater	No effects expected.
		Drainage systems	Surface water discharges from the above ground track drainage will be collected, attenuated and discharged to existing sewerage infrastructure. No significant effects expected.
		Artificial sources	No effects expected.
Camley Street	Less vulnerable	Surface water 200 years - deep Hampstead and Highgate ponds failure	Existing developments to be demolished. No effects expected.
Properties on Hawley Street and Kentish Town Road	More vulnerable	Surface water 200 years - deep	No increase in built footprint in carriageway. No effects expected.
Shops and bars on Chalk Farm Road close to Morrisons supermarket	Less vulnerable	Surface water 200 years - deep	No increase in built footprint in carriageway. No effects expected.

9 Conclusions

9.1 Summary

9.1.1 The Proposed Scheme within CFA2 extends from the A5200 York Way in the east, to Regent's Park Road Bridge in the west. The study area includes all areas within 500m of the Proposed Scheme, which includes areas at risk of flooding from all sources as follows:

- areas at risk of surface water flooding; and
- areas with a residual risk of flooding due to the failure of the Hampstead and Highgate Ponds.

9.1.2 The Proposed Scheme will be raised above ground level on an existing railway viaduct throughout the majority of this study area. Drainage will be provided to ensure that the top of rail levels of the Proposed Scheme will be at least 1m above design flood water levels within all areas at risk of flooding. Residual risks from these sources will be negligible.

9.1.3 This study area is heavily urbanised with substantial residential and industrial areas within the study area. There are areas at risk of flooding as a result of direct surface water runoff in rainfall events as well as overloaded sewers and failed water mains. Surface water runoff from the Proposed Scheme will be collected, attenuated and discharged to existing sewers at pre-agreed rates and will not create an additional burden on the existing drainage infrastructure. There will be no increased risk of failure to underground surface water infrastructure from the Proposed Scheme.

9.1.4 There will be no significant increase in the risk of flooding to third party receptors arising from the Proposed Scheme.

9.2 Residual flood risks to Proposed Scheme

9.2.1 There will be no significant residual risks of flooding to the Proposed Scheme.

9.3 Residual effects of the Proposed Scheme on flood risk

9.3.1 The Proposed Scheme will not create an additional risk of blockage of sewer systems and will not lie within any area of significant risk of flooding. There will therefore be no significant impact arising from the Proposed Scheme on the residual risk of flooding to third parties.

9.4 Compliance with local planning policy

9.4.1 The Proposed Scheme includes an allowance for future increases in the risk of flooding as a result of climate change by adding a 30% increase to rainfall intensities and flows in minor watercourses as recommended in the NPPF Technical Guidance document. Attenuation will be provided to ensure that the rate of runoff from permanent infrastructure, such as at the HS1-HS2 Link portal, will not increase as a result of the Proposed Scheme. This will ensure that there will be no increase in the risk of surface water flooding, especially in areas where a risk currently exists. The

Proposed Scheme will be in compliance with the recommendations of the LBC SFRA, Core Strategy and adopted Development Policies.

10 References

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